The Accuracy of Height and Weight Values Reported by Turkish Adults and Their Validity in Diagnosing Overweight and Obesity

Türk Yetişkin Bireyler Tarafından Bildirilen Boy ve Ağırlık Değerlerinin Doğruluğu ve Şişmanlık Tanısındaki Yeri

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ABSTRACT Objective: Body mass index (BMI) is an important measure to evaluate the body weight. BMI values may be calculated from the reported height and weight and obesity may be diagnosed correctly in case of an accurate estimate of height and weight values. This investigation was performed to evaluate the validity of the BMI, calculated from the self reported height and weight values, in the diagnosis of overweight and obesity. **Material and Methods:** It was conducted upon 1238 individuals in Kayseri, Turkey. A questionnaire comprising 30 questions was applied. Also height and weight measurements were taken. The coherence between the BMI values calculated from the reported and measured values and also the validity of the BMI calculated from the reported values, in the diagnosis of overweight and obesity were evaluated. Unpaired t test, paired t test, one way ANOVA test, Pearson's correlation analysis and Kappa analysis were used for statistical analyses. **Results:** It was established that individuals reported their height higher and their weight lower than it was. Absolute difference between the reported and measured values was 1.9 ± 2.1 cm for height, and 1.9 ± 1.8 kg for weight. The sensitivity and specificity of the BMI calculated from the reported weight and height values in the diagnosis of overweight and obesity were found to be 92.3% and 94.4% respectively. **Conclusion:** BMI values calculated from the weight and height values reported by adult individuals can be used as a valid method in the diagnosis of overweight and obesity. But, the validity of self-evaluation of the individuals is low.

Key Words: Body mass index; overweight; obesity; self assessment (psychology)

ÖZET Amaç: Beden kitle indeksi (BKİ), vücut ağırlığının değerlendirilmesinde kullanılan önemli bir ölçüttür. Bireylerin kendi boy ve ağırlıklarını doğru bildirmeleri halinde, yeniden ölçüm yapılmasına gerek kalmadan, BKİ değerleri hesaplanabilir ve şişmanlık tanısı doğru olarak konulabilir. Bu çalışma, bireylerin özbildirimine dayalı boy ve ağırlık verilerinden hesaplanan BKİ değerlerinin şişmanlık tanısındaki geçerliliğini değerlendirmek amacıyla yapılmıştır. **Gereç ve Yöntemler:** Kayseri ilinde 1238 kişiye 30 sorudan oluşan anket formu uygulandı, ayrıca, boy ve ağırlık ölçümleri yapıldı. Bireyler tarafından bildirilen ve ölçülen boy ile ağırlık verilerinden hesaplanan BKİ değerlerinin uyumu incelendi ve bildirilen boy ve ağırlık verilerinden hesaplanan BKİ değerlerinin şişmanlık tanısındaki geçerliliği değerlendirildi. Verilerin istatistiksel analizinde eşleşmemiş t testi, eşleşmiş t testi, tek yönlü ANOVA testi, Pearson korelasyon analizi ve kappa analizi kullanıldı. **Bulgular:** Bireylerin, boy değerlerini olduğundan uzun, ağırlık değerlerinin olduğundan az olarak bildirdiği belirlenmiştir. Bildirilen ve ölçülen değerler arasındaki mutlak farklar, boy değerleri için 1,9 ± 2,1 cm, ağırlık değerleri için 1,9 ± 1,8 kg bulunmuştur. Bildirilen boy ve ağırlık değerlerinden hesaplanan BKİ değerlerinin hafif şişmanlık ve şişmanlık tanısındaki duyarlılığı ve özgüllüğü sırasıyla %92,3 ve %94,4 olarak tespit edilmiştir. **Sonuç:** Yetişkinler tarafından bildirilen boy ve ağırlık verilerinden hesaplanan BKİ değerleri hafif şişmanlık ve şişmanlık tanısında geçerli bir yöntem olarak kullanılabilir. Ancak, bireylerin kendileri tarafından yapılan değerlendirmelerin geçerliliği düşüktür.

Anahtar Kelimeler: Vücut kitle indeksi; kilolu; şişmanlık; kendi kendini değerlendirme (psikoloji)

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The awareness of a society about height and weight is related to general health, nutrition level, and the perception of fatness and other diseases. The use of reported height and weight, is cost-effective in the epidemiological studies those are using these parameters and is a facility in field studies.[1,2]

Obesity prevalence is increasing throughout the world. As a result height, weight and body mass index (BMI) are frequently emphasized. Although height and weight can be easily measured, the reported height and weight values can also be used.[1] But the reported and measured values have to be compared. There are some studies from various countries showing the validity of the reported values.[2,3]

Bolton-Smith and friends[1] have shown that the reported weight and height are sufficient in establishing obesity prevalence in the society. Obesity prevalence in the society can be below then expected when calculated from the reported height and weight in young women and elderly individuals. Therefore the validity of the reported values can varies according to the gender, age, and socio–economic factors. Usually a lower weight is reported by women and a higher height by men. In studies performed in different age groups, the difference between the reported and measured values was found greater in the elderliness.[2,4]

This study was performed to evaluate the accuracy of the reported height and weight values by adult individuals in Turkey and their validity in diagnosing overweight and obesity.

MATERIAL AND METHODS

STUDY DESIGN AND PARTICIPANTS

This study was performed with the approval of Erciyes University Medical Faculty Ethical Committee.

Kayseri is a province in the central part of Turkey. Total population of the province is approximately 1.2 million and 70 percent of the total population live in the provincial center. It was assumed that mean and standart deviation of the absolute differences between the reported and measured weight values may be approximately 2.0 ± 1.0 kg. Minimum sample size was calculated to be 786 with 0.95 confidence level, 0.80 power and 0.1 tolerence value. It was planned that at least 1000 people should be taken in study sample.

Among the patients who referred to primary health care centers in June 2008, a total of 1320 people, 661 men and 659 women, above 18 years of age, who accepted to participate, were interviewed. Pregnant women and patients having with dehydration were not included. Eighty two questionnaires were excluded due to incomplete answers. A total of 1238 people were included.

PROCEDURES

The questionnaire, comprising 30 questions prepared by the investigators, was filled by educated interviewers by the face-to-face interviewing method. Height measurements were done barefoot, with a measuring tape. Weight measurements were done again barefoot, with thin clothes on, using a digital bathroom scale.

Apart from the questions about the socio-demographic characteristics, questions regarding their height and weight measurement frequencies and their self-evaluation about their own height and weight were asked.

Taking into account the reported and measured height and weight values, two different BMI values were calculated for each individual and they expressed as “reported BMI” and “measured BMI” respectively. BMI values below 18.5 was accepted as thin, between 18.5-24.9 as normal, between 25-29.9 as overweight and 30 and above as obese.[5]

ANALYSES

The absolute values of the differences between the reported and measured values were calculated in order to establish the accuracy of the reported height, weight and BMI values, and expressed as “absolute difference”. The fitness of “absolute difference” values to normal distribution was tested by Kolmogorov-Simirnov test. Numerical values were shown as “mean ± SD”. Unpaired t test, paired t test, one-way ANOVA test (post hoc Scheffe), Pearson’s correlation analysis and cappa analysis

were used for statistical analyses. Bland-Altman plot was used to show the aggrement between "reported BMI" and "measured BMI" values. In order to evaluate the validity of "reported BMI" values in the diagnosis of overweight and obesity, the sensitivity and spesificity were calculated taking reference "measured BMI". $p< 0.05$ was accepted as significant in all statistical analyses.

RESULTS

Of the 1238 individuals in the study group, 51.8% were male and 48.2% female. Age range was 18-83 years with a mean 38.7 ± 14.2.

There were found strong correlations between the reported and measured height, weight and BMI values. Pearson's correlation coefficients were calculated to be 0.952 ($p< 0.001$) for height, 0.982 ($p< 0.001$) for weight, and 0.963 ($p< 0.001$) for BMI values. A good coherence was determined between "reported BMI" and "measured BMI" values as shown in Figure 1.

On the other hand, it was established that the reported height values were 0.05± 2.85 cm higher ($p> 0.05$) and the weight values were 0.75 ± 2.50 kg lower ($p< 0.001$) than the measured values. BMI values calculated from the reported height and weight were established 0.31 ± 1.31 kg/m^2 lower than the BMI calculated from the measured values (Table 1).

The means of absolute differences between the reported and measured values were calculated as 1.94 ± 2.08 cm for height, 1.90 ± 1.79 kg for weight, and 0.96 ± 0.94 for BMI. The distributions of these values according to different characteristics of individuals were given in Tables 2, 3, and 4.

As seen in Table 2 and 3, the absolute differences between the reported and measured height and weight values increase as age increases and decrease as educational level increases. Although the absolute weight difference showed no change with gender, the absolute height difference was significantly lower in men (Table 2 and Table 3).

The absolute differences between the reported and measured BMI values were less in men than women, and less in people who had a bathroom scale at home compared to those who hadn't and they increased as age increased; and decreased as educational level increased (Table 4).

Sensitivity and specificity of "reported BMI" were calculated in order to evaluate its validity in the diagnosis of overweight and obesity (Table 5).

"Reported BMI" values have classified correctly 92.3% of overweights and obeses (sensitivity), and 94.4% of those who were not overweight or obese (spesificity) (Table 4). But, when the obesity was evaluated alone (BMI> 30 kg/m^2), sensitivity of the reported BMI values was found 77.8% and specificity 98.1%. Sensitivity and specificity of self-evaluation of the individuals for diagnosis of overweight and obesity were established as 72.0% and 87.3% respectively.

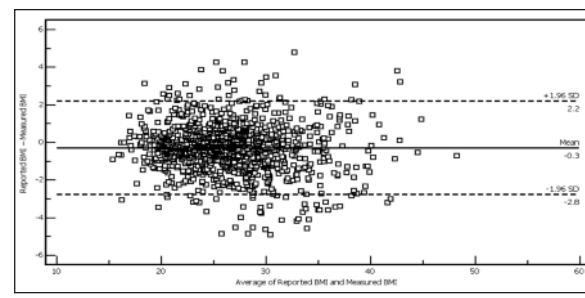

FIGURE 1: Bland-Altman plot for the reported and measured BMI values.

TABLE 1: Comparison of the reported and measured height, weight and BMI values.

Measurements (n= 1238)	Reported (mean±SD)	Measured (mean±SD)	Difference (mean±SD)	t	p
Height (cm)	166.66 ± 9.10	166.61 ± 9.22	0.05 ± 2.85	0.66	0.509
Weight (kg)	72.93 ± 13.22	73.68 ± 13.35	-0.75 ± 2.50	10.56	<0.001
BMI (kg/ m^2)	26.31 ± 4.75	26.62 ± 4.88	-0.31 ± 1.31	8.21	<0.001

TABLE 2: The absolute differences between the reported and measured height values, according to socio-demographic characteristics of the study group.

Characteristics	Groups	n	Absolute Difference (cm) (mean ± SD)	t/F	p
Gender	Male	641	1.73 ± 1.90[a]	t= 3.68	<0.001
	Female	597	2.17 ± 2.56[b]		
Age Groups (years)	18-29	375	1.83 ± 2.11[a,b]	F= 10.12	<0.001
	30-39	341	1.51 ± 1.77[a]		
	40-49	226	2.04 ± 2.05[b,c]		
	50-59	173	2.39 ± 2.18[b,c]		
	60 and above	123	2.66 ± 2.44[c]		
Educational Level	Not finished primary	106	2.68 ± 2.53[a]	F= 21.09	<0.001
	Primary school	475	2.42 ± 2.21[a]		
	Junior high school	152	1.88 ± 1.91[a,b]		
	High school	303	1.51 ± 1.80[b]		
	University	202	1.18 ± 1.63[b]		
Residence	Provincial center	950	1.91 ± 2.08[a]	F= 0.68	0.643
	District center	186	2.10 ± 2.30[a]		
	Town-village	102	1.94 ± 1.76[a]		
Last Date of Height Measurement	Within last month	184	1.33 ± 1.66[a]	F= 13.09	<0.001
	1-6 months ago	195	1.57 ± 1.73[a]		
	7-12 months ago	162	1.77 ± 1.91[a,b]		
	Before than 1 year	697	2.25 ± 2.26[b]		
Total		1238	1.94 ± 2.08		

a,b,c: For each variable, the differences between the groups that do not carry the same letter are significant.

DISCUSSION

Obesity, the most prominent underlying risk factor for many chronic diseases, is an escalating problem in Turkey, as it is worldwide. According to a study performed by Turkish Statistical Institute, 47.2% of the population aged 15 and above in Turkey were found to be overweight or obese.[6] It is of utmost importance that people being aware of their situation for early diagnosis of obesity. One of the most important indicators in establishing obesity is BMI. The measurements reported by the individual himself can also be used for this purpose. Moreover, in many studies, it was established that calculations depending on reported weight and height values were valid indicators even in people with a lower educational level.[2,7-9]

It was determined that the individuals in our study reported their height to be, in mean, 0.05 ± 2.85 cm higher (Table 1). This was similar in many other studies. For example, the evaluation of 53 studies performed until 2006, has shown that height was reported to be higher than the measured values in the great majority of the studies.[10]

In our study, mean absolute difference for height was found as 1.94 ± 2.08 cm (Table 2). On the other hand, it was found that women, especially the elderly and the ones with a lower educational level, usually knew their heights incorrectly. Although, in general, studies have established that women have more incorrect knowledge.[1,11] it is expected for the elderly people to state more incorrect values. Their memory may fail, and also, their height may not be the same that they remember due to the shortening seen in height with aging. As a matter of fact, in studies it is seen that there are higher differences between the reported and measured heights in the elderly people.[12-14] In an analysis investigating similar

TABLE 3: The absolute differences between the reported and measured weight values, according to socio-demographic characteristics of the study group.

Characteristics	Groups	n	Absolute Difference (kg) (mean ± SD)	t/F	p
Gender	Male	641	1.92 ± 1.87[a]	t= 0.48	0.630
	Female	597	1.88 ± 1.72[a]		
Age Groups (years)	18-29	375	1.79 ± 1.77[a,b]	F= 4.19	0.002
	30-39	341	1.67 ± 1.48[a]		
	40-49	226	2.07 ± 2.15[a,b]		
	50-59	173	2.08 ± 1.73[a,b]		
	60 and above	123	2.30 ± 1.93[b]		
Educational Level	Not finished primary	106	2.37 ± 1.64[a]	F= 9.08	<0.001
	Primary school	475	2.12 ± 1.90[a,b]		
	Junior high school	152	2.00 ± 1.67[a,b]		
	High school	303	1.68 ± 1.88[b,c]		
	University	202	1.40 ± 1.41[c]		
Residence	Provincial center	950	1.83 ± 1.80[a]	F= 2.86	0.058
	District center	186	2.10 ± 1.79[a]		
	Town-Village	102	2.16 ± 1.76[a]		
Bathroom Scale at Home	Yes	513	1.57 ± 1.51[a]	t= 5.83	<0.001
	No	725	2.14 ± 1.94[b]		
Frequency of Weight Measurement	Everyday	104	1.15 ± 1.24[a]	F= 26.55	<0.001
	Once a week	246	1.31 ± 1.32[a]		
	Once a months	315	1.85 ± 1.69[b]		
	Less than once a month	570	2.31 ± 1.99[b]		
Total		1238	1.90 ± 1.79		

a,b,c: For each variable, the differences between the groups that do not carry the same letter are significant.

studies performed until 2002, it was found that in eight studies the error increased with age, on the opposite in three studies it decreased with age and in three studies there was no difference between the age groups.[15]

Education is a factor that provides a higher awareness, and more emphasis is placed in the follow-up and in remembering correctly. In three out of four studies that investigated education, it was found that as educational level increases, incorrect statement decreases.[15]

The individuals in the study group reported their weight, in average, 0.75 ± 2.50 kg less than the measured value (Table 1). When the absolute differences were taken into account, the difference increased to 1.90 ± 1.79 kg (Table 3). Studies show that people usually state a lower weight than the measured value. For example, in all 34 studies performed until 2002, the weight reported by individuals was 0.2 to 3.54 kg less than the measured weight.[15] Again in an analysis investigating 56 studies performed until 2006, except in 2 studies, the measured weight was found to be higher than the reported values.[10] In a study, the difference was as high as 19 kg.[16] This can be the result of the individuals' desire to see themselves thinner, or else it can also be an indication of how easily weight can be gained without even realizing it.

Mean absolute difference for weight was similar in men and women, but it was higher in the elderly and in those with a lower educational level (Table 3). In other words, it might be thought that younger and more educated people follow their weight more carefully. There are studies those found no difference according to age

TABLE 4: The absolute differences between the reported and measured BMI values, according to different characteristics of the study group

Characteristics	Groups	n	Absolute Difference (kg/m^2) (mean ±SD)	t/F	p
Gender	Male	641	0.85 ± 0.85[a]	t = 4.02	<0.001
	Female	597	1.07 ± 1.03[b]		
Age Groups (years)	18-29	375	0.80 ± 0.83[a,b]	F=15.38	<0.001
	30-39	341	0.78 ± 0.77[a]		
	40-49	226	1.04 ± 1.08[b,c]		
	50-59	173	1.27 ± 1.09[c]		
	60 and above	123	1.30 ± 1.01[c]		
Educational Level	Not finished primary	106	1.30 ± 1.05[a]	F=19.57	<0.001
	Primary school	475	1.14 ± 1.05[a]		
	Junior high school	152	0.87 ± 0.81[a,b]		
	High school	303	0.78 ± 0.82[b,c]		
	University	202	0.67 ± 0.82[c]		
Residence	Provincial center	950	0.94 ± 0.94[a]	F=1.62	0.197
	District center	186	1.07 ± 1.06[a]		
	Town–Village	102	0.90 ± 0.70[a]		
Bathroom Scale at Home	Yes	513	0.83 ± 0.86[a]	t=-4.12	<0.001
	No	725	1.05 ± 0.99[b]		
Frequency of Weight Measurement	Everyday	104	0.62 ± 0.66[a]	F=16.16	<0.001
	Once a week	246	0.76 ± 0.78[a,b]		
	Once a months	315	0.89 ± 0.88[b,c]		
	Less than once a month	570	1.14 ± 1.05c		
Total		1238	0.96 ± 0.94		

a,b,c: For each variable, the differences between the groups that do not carry the same letter are significant.

TABLE 5: The validity of Reported BMI values and self-evaluation of the individuals in the diagnosis of overweight and obesity.

Reported BMI	Measured BMI ≥25 Number	%	<25 Number	%	Total Number	%	Kappa
≥ 25	699	92.3	27	5.6	726	58.6	0.857
<25	58	7.7	454	94.4	512	41.4	p< 0.001
Self–Evaluation of the Individual							
Overweight or Obese	545	72.0	61	12.7	606	48.9	0.561
Thin or Normal	212	28.0	420	87.3	632	51.1	p< 0.001
Total	757	100.0	481	100.0	1238	100.0	

between the reported and measured values,[12] and also studies that found higher error rates in younger people.[11] Out of 17 studies, weight difference increased in five and decreased in six studies as age increased.[15]

In four out of nine studies those investigated the relationship between education and the reported and measured values; the error rate increased as educational level increased, in two studies the error rate decreased as educational level

increased and in three there was no relationship with education.[15]

Mean absolute difference for weight was higher in people who didn't have a bathroom scale at home, in those that weighed themselves once a month or less (Table 2). As body weight is a parameter that can change even in brief periods, having a bathroom scale at home and weighing oneself frequently, shows the importance the person gives to weight measurement, and therefore they usually have the right knowledge.

Body mass index, is the most important indicator in diagnosing and classifying obesity. In this study, reported BMI values were, in average, 0.31 ± 1.31 kg/m^2 less than the measured BMI values (Table 1), and the absolute difference between the two calculations was 0.96 ± 0.94 kg/m^2 (Table 4). In many studies, a small difference was established between the BMI values calculated from the reported and measured values, and in some studies no significant difference was found. For example, in 18 of the 29 studies performed until 2006, there were significant differences between BMI values calculated from the reported and measured values.[10] In a study from Canada, mean of BMI values calculated from the reported height and weight values was 1.16 kg/m^2 lower than the BMI calculated from the measured values,[17] in a study from Spain 0.71 kg/m^2 lower,[18] in a study from France 0.29 kg/m^2 lower in men, and 0.44 kg/m^2 lower in women,[19] in a study from Turkey 2.5 kg/m^2 lower in the reproductive age women,[20] whereas in a study performed in Scotland, the BMI calculated from the reported values was 0.19 kg/m^2 higher in men, and 0.17 kg/m^2 higher in women than the BMI calculated from the measured values.[1]

The difference between the reported and measured BMI values is higher in women, elderly people, low educated people, and in people who do not have a bathroom scale at home (Table 3). These groups, as discussed before, are the ones those know their weight and/or height incorrectly. In some other studies as well, higher differences were established between the BMI values calculated from the reported and measured values, in women and in the elderly.[4,11]

It was determined that the sensitivity and spesificity of reported BMI values in the diagnosis of overweight and obesity (BMI> 25 kg/m^2) were substantially high (92.3% and 94.4 % respectively) (Table 4). When the obesity was evaluated alone (BMI>30 kg/m^2), sensitivity was found 77.8% and specificity 98.1%. In several studies it was found that as the BMI of individuals increased, the incorrect statement rate also increased.[12,21]

In many studies performed upon people with a body mass index above 30, validity was found to be similar. For example in a study from Spain the sensitivity was 77% and specificity was 99%,[18] in a study from the USA sensitivity was 74% and specificity was 99%,[15] and in a study from France the sensitivity in men was 72.3% and in women 76.9%.[19] Our results regarding validity were found to be higher than a study performed in Sweden that showed a sensitivity of 61% in men, and 55% in women[22] and one from Spain with a sensitivity of 57%.[23]

On the other hand, when the perceptions of the individuals about their weight were taken into account, it was determined that the sensitivity was 72.0% and specificity was 87.3% for the diagnosis of overweight and obesity (Table 4). This result shows that especially the obese individuals don't evaluate their status correctly. This can be so either because they do not know the limits of overweight and obesity exactly, or else, they don't desire to see themselves as obese.

In conclusion, there is a good coherence between the BMI values calculated from the reported and measured height and weight values. The BMI values calculated from the height and weight values reported by individuals can be used when there is no possibility to measure weight or height. The evaluation which was done according to the individuals' perception about themselves has a low sensitivity in diagnosing overweight and obesity. BMI calculation and evaluation should be taught to individuals, in order to provide an objective evaluation of their own body weight. Having a bathroom

scale at home, and weighing once a week is found to be enough to follow body weight.

STUDY LIMITATIONS

This study was performed among individuals who referred to primary health care centers and the results may not be generalizable to the whole population.

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